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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/063,574	05/03/2002	Ho-Ming Tong	8382-US-PA	4445

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JIANQ CHYUN INTELLECTUAL PROPERTY OFFICE
7 FLOOR-1, NO. 100
ROOSEVELT ROAD, SECTION 2
TAIPEI, 100
TAIWAN

EXAMINER

TRINH, HOA B

ART UNIT PAPER NUMBER

2814

DATE MAILED: 04/29/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/063,574

Applicant(s)

TONG ET AL.

Examiner

Vikki H Trinh

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-112 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-112 is/are rejected.
- 7) ☐ Claim(s) ____ is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on ____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) ____.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). ____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

2. Claims 1, 18, 35, 54, 73, 94 are rejected under 35 U.S.C. 102(a) as being anticipated by Admitted Prior Art (APA), figures 1-7.

APA discloses the following steps:

As to claims 1, 18, 35, 54, 73, 94, a method of forming bumps on a silicon wafer 110 having an active surface 112 with a passivation layer and a plurality of bonding pads 116 thereon such that the passivation layer 114 exposes the bonding pads 116, the method comprising the steps of: forming an adhesion layer 120 over the active surface 112 of the wafer 110, covering both the bonding pads 116 and the passivation layer 114; forming a barrier layer 130 over the adhesion layer 120; forming a wettable layer 140 over the barrier layer; conducting a first photolithographic process to form a plurality of photoresist blocks 150 on the wettable layer; conducting a first etching operation to remove the wettable layer 140 and the barrier layer 130 outside the photoresist blocks 150 so that only the residual wettable layer and barrier layer underneath the photoresist blocks remain; removing the photoresist blocks; conducting a second photolithographic process to form a photoresist layer over the adhesion layer, wherein the photoresist layer has a plurality of openings that expose the wettable layer and the adhesion layer around the barrier layer; conducting a metal-filling operation to form solder blocks inside the

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openings of the photoresist layer, wherein the solder blocks cover the wettable layer and the adhesion layer around the barrier layer; removing the photoresist layer; conducting a first reflux operation to transform the solder blocks into a blob of material having a hemispherical profile such that the solder blocks also retract onto the upper surface of the wettable layer without extending into the adhesion layer; conducting a second etching operation to remove the exposed adhesion layer so that only residual adhesion layer underneath the barrier layer is retained and the passivation layer on the wafer is exposed; and conducting a second reflux operation. See specification, page 2, paragraphs 5-9, and figures 3, 6, 7.

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.

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3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

3. Claims 2, 19, 36, 55, 74, 95, 3, 20, 37, 56, 75, 96, 14, 31, 48, 67, 86, 107, 16, 33, 50, 69, 88, 109, 17, 34, 51-53, 70-72, 89-93, 110-112 are rejected under 35 U.S.C. 103(a) as being unpatentable over APA in view of Datta et al. (5,486,282).

APA discloses the invention substantially as claimed. However, APA does not explicitly teach the specific material of the adhesion layer and the etchant.

Datta et al. '282 teaches a device and process of forming bumps having the adhesion layer 2 is selected from a group consisting of titanium, titanium-tungsten alloy, aluminum and chromium, and the etchant for etching the adhesion layer in the second etching operation contains hydrogen peroxide (H_2O_2), ethylene diamine tetraacetic (EDTA) and potassium sulfate (K_2SO_4) when the adhesion layer is a titanium-tungsten alloy layer. See figure 3 and column 6, lines 25-30, col 7, lines 10-25, col 9, lines 25-30.

Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made, in view of Datta et al. to modify the adhesion layer and the etchant material of APA with those, as taught by Datta et al., for enhancing the uniformity of the etching layer. See Datta et al., col 5, lines 48-50.

As to claims 14, 31, 48, 67, 86, 107, wherein material constituting the wettable layer is selected from a group consisting of copper, palladium and gold. See Datta et al., abstract.

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As to claims 15,32,49,68,87,108, wherein the wettable layer is etched in the first etching operation using an etchant containing ammonium hydroxide and hydrogen peroxide if the wettable layer is a copper layer. See Datta et al., abstract.

As to claims 16,33,50,69,88,109, wherein the wettable layer is etched in the first etching operation using an etchant containing potassium sulfate (K_2SO_4) and glycerol if the wettable layer is a copper layer. See Datta et al., figure 3 and column 6, lines 25-30, col 7, lines 10-25, col 9, lines 25-30.

As to claims 17,34,51-53,70-72,89-93,110-112, wherein material constituting the solder blocks does not wet the adhesive layer, the first under ball metallic layer. See Datta et al., figure 3 and column 6, lines 25-30, col 7, lines 10-25, col 9, lines 25-30.

4. Claims 4, 21, 38,57,76,97, 5,22,39,58,77,98, 6,23,40,59,78,99, are rejected under 35 U.S.C. 103(a) as being unpatentable over APA in view of Yung (5,162,257)

APA discloses the invention substantially as claimed. However, APA does not explicitly teach the etchant for etching the adhesion layer in the second etching operation contains hydrogen chloride (HCl) when the adhesion layer is a chromium layer; or the adhesion layer in the second etching operation contains ammonium hydroxide (NH_4OH) and hydrogen peroxide (H_2O_2) when the adhesion layer is a titanium layer; or the etchant for etching the adhesion layer in the second etching operation contains hydrogen fluoride (HF) when the adhesion layer is a titanium layer.

Yung teaches the specific material that APA lacks. See col 3, lines 60-68, col 4, lines 45-50, col 4, lines 60-65.

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Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made, in view of Yung, to modify the adhesion layer and the etchant material of APA with those, as taught by Yung, so as to enhance the bumps connection with electrical reliability. See col 3, lines 8-9.

5. Claims 7,,24,41,60,79,100, 8,25,42,61,80,101, 9,,26,43,62,81,102, 13,30,47,66,85,106, are rejected under 35 U.S.C. 103(a) as being unpatentable over APA in view of Baker (5,508,229).

APA discloses the invention substantially as claimed. However, APA does not explicitly teach the etchant for etching the adhesion layer in the second etching operation contains phosphoric acid and acetic acid when the adhesion layer is an aluminum layer.

Baker teaches etchants made of phosphoric acid, sulfuric acid and acetic acid when the adhesion layer is an aluminum layer 36, and the barrier layer is nickel-vanadium alloy. See col 4, table 1, col 3, lines 25-30..

Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made, in view of Baker, to modify the materials of the barrier layer, adhesion layer and the etchant material of APA with those, as taught by Baker, so as to increase the efficiency of forming the solder bumps. See col 2, lines 38-39.

As to claims 13,30,47,66,85,106, wherein the barrier layer is etched using diluted phosphoric acid in the first etching operation. See col 4, table 1.

6. Claims 10,28,45,64,83,104, 11,28,45,64,83,104, 12,29,46,65,84,105, are rejected under 35 U.S.C. 103(a) as being unpatentable over APA in view of Baker (5,508,229).

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The combined teaching of APA and Baker discloses the invention substantially as claimed. However, APA and Baker do not explicitly teach that the barrier layer having a thickness between 2000 Å to 4000 Å is etched for over 2 hours at room temperature using a sulfuric acid etchant having a concentration between 1 % - 98%; or the barrier layer having a thickness between 2000 Å, to 4000 Å, is etched for over 2 hours at 80 ° C using a sulfuric acid etchant having a concentration between 1% - 98%; or the barrier layer having a thickness between 2000 Å to 4000 Å is etched in the first etching operation by conducting an electrochemical etching operation at room temperature for 20 to 110 seconds using a current density between 0.001 - 0.02A/cm² and sulfuric acid at 10% concentration.

Nonetheless, it would have been obvious to one skilled in the art at the time the invention was made to provide a specific range of thickness, of etchant's concentration range, temperature range, current density range, and time, since it is prima facie obvious to an artisan's experimentation and optimization because applicant has not established any criticality for those specific ranges.

Election/Restrictions

Upon reconsideration, the examiner has withdrawn the restriction requirement in the previous Office Action. All claims in this present application have been examined in this Office Action to advance the prosecution process.

Conclusion


5. Any inquiry concerning this communication or earlier communications from the Examiner should be directed to Vikki Trinh whose telephone number is (703) 308-8238. The Examiner can normally be reached Mon-Tuesday, Thurs-Friday, 7:30 AM - 6:00 PM

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Eastern Time. If attempts to reach the examiner by telephone are unsuccessful, the Examiner's supervisor, Mr. Wael Fahmy, can be reached at (703) 308-4918. General inquiries relating to the status of this application should be directed to the Group receptionist at (703) 308-0858. The fax number is (703) 308-2708.



Vikki Trinh,
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AU 2814



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PRIMARY EXAMINER